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Information technologies for development

An issues note

Note by the UNCTAD secretariat

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EXECUTIVE SUMMARY

The rapid advancement in information technology (IT) in recent years continues to transform the global economy through its effects on information processing, productivity and competitiveness. Technology advances and the low cost and miniaturization of microchips, a key component of information technology, have offered new opportunities in terms of access to and use of information technology. This has led to the spread of information technology in all aspects of social and economic activities in both industrialized and developing countries.

However, to date, the diffusion of IT in most developing countries and economies in transition has been slow, especially in the former. The reasons for this are different in the two cases. Whereas, in developing countries, particularly the least developed among them, the causes can be traced to lack of specific IT strategies and policies, low levels of technical personnel, lack of supporting infrastructure, lack of investments, and inability to keep pace with rapidly changing technology, in the case of the economies in transition, the problems are related to the need to improve and redeploy telecommunications and current information technology infrastructure and other resources from military to civilian use. Developing countries in general have the opportunity to leapfrog by acquiring information technology and pursuing an explicit policy in this field, provided they have the necessary infrastructure and institutional support, including the requisite skills.

The issues raised in this note are intended to assist the Commission on Science and Technology for Development in the consideration of its future work programme.

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Introduction

1. At its first session (12 to 23 April 1993), the Commission on Science and Technology for Development decided that, in addition to the panels for the three substantive themes for its second session, work in the area of information technology (IT), in particular with reference to the needs of developing countries, should be undertaken so that the Commission might consider it as a possible substantive theme for its inter-sessional period 1995-1997. This note attempts to identify some of the main issues in this area that might be considered by the Commission in the future. The note outlines the key features of information technology, its role in the newly evolving global order, some of the social, economic and legal implications of the diffusion of information technology and the constraints associated with its development and diffusion in developing countries. Finally, an attempt is made to identify some of the key issues that require further consideration.

Some key issues in information technology

2. For the purpose of this note, information technology refers to electronics-based technology which can be used to collect, store, process, package information and provide access to knowledge.1/ The pace of technological change in information technology in recent years has led to revolutionary changes in the processing and dissemination of data and to the emergence of an information society, with immense effects on production, services, cultural values, economic development, organization of labour, the environment and society as whole.

3. The market for information technology, however, remains geographically concentrated. According to one estimate, in 1993 the total world market for information technology amounted to $450 billion. Over 90 per cent of that market was concentrated in advanced industrialized countries, notably the United States (39 per cent), Western Europe (34.5 per cent) and Japan (29.6 per cent).2/ The share of four newly industrialized Asian countries and territories (Hong Kong, the Republic of Korea, Singapore and Taiwan, Province of China) was 1.5 per cent, while that of Eastern Europe was 0.8 per cent. The total for the rest of the world was 8 per cent.

4. In assessing the development and diffusion of information technology globally, three groups of countries may be distinguished: countries that are leaders in this field, including the production and generation of information technology, its application and diffusion (for example most of the OECD member countries); those where some capacity in the production and application of information technology (both hardware and software) has been developed but which, for the most part, still rely on imports from the first group for the diffusion of information technology (for example, several countries in Asia, some economies in transition and a number of countries in

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1/ It comprises, therefore, both the supply side (computer hardware and software as well as electronics-component industries) and the demand or user side (informatics applications in all economic sectors, information services industry, electronic publishing, broadcasting, and management information systems, for example).

2/ See, Yehia, Soubra, "Trends and current situation in the diffusion and utilization of information technology", in **Information Technology for Development, ATAS Bulletin**, issue 10 (forthcoming, 1995).

Latin America);3/ and those where the application of information technology is still in an embryonic stage and access to it depends solely on imports. It should be noted, moreover, that differences in accessing information technology exist not only between countries but also, and perhaps more importantly, between sectors and social groups within countries.

5. A core component of information technology is the semi-conductor chip which, since the early 1980s, has not only decreased in size and cost but has also increased steadily in capacity and complexity. 4/ These developments have enabled computers to evolve from room-size machines to palm-size devices. Moreover, the low cost and miniaturization of microchips have offered new opportunities in terms of access to and use of information technology. They have also led to the spread of information technology in all aspects of social and economic activities in both industrialized and industrializing countries. In manufacturing, and to some extent in agriculture, the introduction of information technology in designing, production processes and distribution has resulted in a drastic fall in costs, as well as improved technical performance. Recent advances in information technology systems have also enabled transnational corporations to transmit technical and economic information among numerous information technology systems at different geographical locations and involving widely dispersed industrial plants.5/ In this way, information technologies have created a symbiosis between development in the manufacturing sectors and that in the service sectors.6/ The effects of these developments on the international division of labour and production, as well as the globalization of the world economy, have been significant.

6. The application and diffusion of information technology must be seen in conjunction with the developments in telecommunications technology, in the sense that while information technology processes and packages information, telecommunications allow information technologies, to interact with other information technologies, as well as remote devices in networks, thereby permitting users to access databases and communicate with other users at long distances. The combination of information technology and telecommunications technology has greatly enhanced existing service industries and spun off

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3/ In some cases, the initial introduction of IT production capacity in these countries was the result of investment by advanced country firms to take advantage of low-wage locations, but deliberate policies have also been followed to build capabilities in IT and learn from locally based foreign firms through joint-venture arrangements and backward-linkaged activities.

4/ For example, the first electronic digital computer - the ENEAC, which was built in 1945 - weighed 5 tons, cost $5 million and had less processing power (10,000 instructions per second) than a microprocess or 5 millimetres square that costs less than $5 today.

5/ It is now common, for example, to design a product in one country, transfer the design electronically to another country for further development, assemble the product in a third country, package it in a fourth country, and finally market it in a fifth country. To do this, however, modern production requires a flexible system and strong links that mould design, management, production and marketing into one integrated system. This integrated system is realized through the application of IT, which provides the means for effective communication.

6/See, UNCTAD: Trade and Development Report, 1988, annex 5, "Technology issues in information services", pp, 257-262.

numerous new ones. It has increased the productivity, quality and efficiency of banking, business management, administration, education and health-care services. It has also allowed greater mobility and flexibility in capital and financial movements and "transborder data flows". 7/ It is this combination of information technology and telecommunications that has given meaning to the global information network and the development of a global information infrastructure (GII).

7. In a rapidly evolving world order, information is the ultimate currency of change that influences access to resources and the method and speed of delivery, enhances the efficiency of the production process, helps to improve trade and competitiveness, and facilitates the transfer, dissemination and application of technology.8/ The importance of access to information, as well as its efficient dissemination, is widely recognized in the industrialized countries and demonstrated by the new alliances that are being formed between Governments and enterprises in an attempt to strengthen their participation in the global information network.9/ A number of OECD countries have also developed a broad range of policies consisting of support for information protection, information technology production, diffusion policies to promote information technology use, and programmes to build common infrastructure and facilitate bridge-building between users and producers.10/ This contrasts with the situation in a number of developing countries, particularly the least developed African countries, where there are no national information technology diffusion policies and the infrastructure needed to facilitate regular flows of relevant information is

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7/ For an analysis of the rapid expansion of the services sector in general and data services in particular and the role of IT and telecommunications in transborder data flows, see Sauvant, Karl, **International Transactions in Services: The Politics of Transborder Data Flows**, the Atwater series on the World Information Economy, No. 1, Boulder, Colorado, and London, Westview Press, 1986.

8/ For an analysis of the importance of access to information for an efficient transfer and diffusion of environmentally sound technologies to developing countries, see "Experiences and problems faced by firms in developing countries in the transfer of environmentally Sound Technologies", a paper presented by H. Argalias at the Workshop on "**The Promotion of Access to and Dissemination of Information on Environmentally Sound Technologies**", Seoul, Republic of Korea, 30 November to 2 December 1994.

9/ The Group of Seven ministerial conference on the development of a global information infrastructure (GII), which was held between 25 and 26 February 1995 in Brussels, is illustrative. The conference brought together ministers, business leaders and IT manufacturers from the Group of Seven industrialized countries to exchange views on the potential benefits of creating a GII and to discuss common approaches towards this objective.

10/ According to Hanna, for example, "technology diffusion programs in OECD countries are estimated to number over 1000, at a net total cost to governments averaging US$70 billion annually, about half of which is targeted directly or indirectly at information technology". See, Hanna, N, "information technology policies in industrialized countries: A shift towards diffusion", in **Information Technology for Development. ATAS Bulletin**, issue 10 (forthcoming, 1995).

limited.11/ According to one commentator, in Africa, information, is one of the "most expensive and scarcest resources".12/ At the present juncture, therefore, the global information network is neither truly global nor accessible to all.13/ Efforts towards remedying this imbalance would involve, among other things, accelerating the diffusion and application of information technology in developing countries.

8. The social and economic effects of the diffusion of information technology have attracted the attention of policy-makers in all countries. In this context, an issue of concern relates to the effects of information technology on employment. One view suggests that the diffusion of information technology would lead to a reduction in the demand for labour, thereby increasing the already high levels of unemployment. However, the available evidence is inconclusive, though two points merit attention: first, the scattered evidence available suggests that, at least in the industrialized countries, unemployment associated with the adoption and application of information technologies is relatively higher in the less-skilled than in the higher-skilled workforce - implying that the negative effects of information technology on employment is confined to specific skill categories; secondly, there is increasing recognition that the long-term positive effects of information technology on employment outweigh the negative short-term effects.

9. Most discussions on information technology focus on its important role in the creation and dissemination of information. Information technology enables the establishment of numerous databases at both the national and the international levels and provides linkages between them through networks. The databases available include information on diverse subjects. While some of these databases are in the public domain, others are privately owned. Moreover, most of these databases are in the industrialized North, where they are available "on-line" for anyone with a home computer and a telephone. Given the scarcity of information in a number of developing countries, therefore, the diffusion of information technology, combined with improvements in telecommunication services, could have a positive effect on the access of developing countries to information.

11/ See, for example, **UNIDO, Computers for Industrial Management in Africa: An Overview of Issues** (PPD.187), February 1991.

12/ See, Juma, C, "Environment, technology and international Trade: beyond financial additionality in Africa", prepared for the seminar on International Trade and Environment, Oslo, Norway, February to 1 March, 1991, p.9.

13/According to Martin Bangemann, the EU's Industry Affairs Commissioner, the development of a global information network will contribute to an easier integration of developing countries into the global economy. He has noted that: "New information and communication technologies, increasingly affordable as their costs, continue to fall, will help developing nations leapfrog entire stages of development in setting up their own infrastructures", and to achieve this "collaborative actions" involving developing countries will be essential. By the same token, the EU's President Jacques Santer has emphasized that: "Developing countries must participate in developments in information technology on an equal footing", because "it is a revolution of the whole planet, not only of the seven industrialized nations". See, "South-North Development Monitor", published by Third World Network in cooperation with Inter-Press Service and South Centre, 23 February 1995.

10. In industrialized countries, electronic mail and networks in general have allowed users to obtain better access to data banks located nationally and internationally. These services are slowly making inroads into developing countries, though at present, getting onto a network such as INTERNET requires investment in support services and efficient telecommunications systems, which are currently unobtainable in a number of developing countries.14/ For the foreseeable future, therefore, the need for investment in support services, as well as the low level of development of telecommunications systems in developing countries, may exclude some of these countries, particularly the least developed among them, from actively participating in the rapidly growing global information network. Thus, in the transition to the twenty-first century, the risk of greater marginalization of low-income economies and low-income social groups from the global information revolution is one important challenges that should be addressed by the international community.

11. The rapid changes arising from the gradual removal of trade barriers in many industrialized and developing countries, as well as countries in transition, have also enhanced the opportunities offered by information technology for efficient and lower-cost trading. Initiatives taken by UNCTAD in this area may help to illustrate the point further. In the recent United Nations National Symposium on Trade Efficiency, held in Columbus, United States of America, calls were made for measures to increase efficiency in international trade, reduce costs and barriers, and improve the participation of poorer countries in rapidly expanding trade and communications networks. To this end, the Symposium launched the Trade Point Global Network, which will consist of trade points located in various regions of the world interconnected in a worldwide electronic network and equipped with efficient telecommunications tools to link up with other global networks. The centralized network allows access to services required for international transactions. In effect, therefore, the "trade efficiency initiative responds to an urgent need to increase the international awareness and effective application of information technologies to trade".15/ A closely related service is the electronic trading opportunities (ETO) system, which provides subscribers worldwide with a single point of contact for their trade and business opportunities. 16/ The (ETO) system, also assist potential traders from diverse countries by matching the trading opportunities between them. Increasingly, therefore, information technology is playing a key role in facilitating trade efficiency and providing opportunities for developing countries to participate effectively in international trade.

14/ However, there are alternatives that are making access to international data-bases possible to many developing country computer users. FIDONET is such a programme. It is a low-cost method of linking computer bulletin board systems through ordinary telephone lines that allow users to overcome the constraints of utilizing the telecommunication systems during peak hours. The network systems automatically contact each other at night, when phone rates are low, to exchange conference postings and electronic mail messages.

15/ UNCTAD, "The trade point: concept and Implementation - note by UNCTAD secretariat", TD/B/WG.2/7/Add.1, 7 October 1993, p.3.

16/ The ETO service is supervised by the Special Programme for Trade Efficiency of the UNCTAD secretariat. The secretariat has also been responsible for the launching of the Automated System for Customs Data 8ASYCUDA), which is a data bank on customs regulations and procedures.

12. Management of the environment is another area which is mutually beneficial to both industrialized and developing countries and where the diffusion of information technology has had positive effects. Information technology enables the processing of a significant volume of scientific, social, geographic and demographic data. This potential, coupled with satellite imaging (remote sensing), could constitute a powerful tool for monitoring environmental degradation, as well as for a more rational exploitation of natural resources. 17/ Recent advances in information technology have also enabled scientists to monitor global environmental phenomena such as ozone depletion, deforestation, drought, desertification, land degradation, and natural resources exploitation. Moreover, through geographic information systems (GIS), it is possible to tackle the problems associated with rapid urbanization in developing countries.

13. From the perspective of the developing countries, the positive aspects of information technology are not only confined to the collection, processing and packaging of information on the environment but extend also to the organization and dissemination of this information "in a manner unique to one's requirements"18/ to meet the needs of users at different levels of development. Whereas in industrialized countries such information may be disseminated "on-line", in most developing countries, characterized by inadequate telecommunications facilities, accessing such information could be arduous, if not impossible. In such cases, one possible option for disseminating information is to use a high-data storage medium, such as CD-ROMS, that can carry picture, sound and text. Before that, however, major obstacles to accessing powerful information technologies need to be overcome.

14. Although the technological revolution in information technology and telecommunications has aroused much interest among policy-makers, the business sector, the media and the academic world in industrialized countries, little is known about the obstacles to accessing information technology and the diffusion and use of information technologies in developing countries, particularly the low-income economies. These issues, especially the impediments to the diffusion of information technology, need to be better understood. As noted above, apart from lack of information, a major obstacle to the diffusion of information technology in the developing world relates to inadequacy of telecommunications systems which are still in the early stages of development.19/ In many countries, high tariff structures imposed by telecommunications monopolies represent key impediments to the diffusion and use of information technology, there is therefore a need to examine the main deficiencies in the existing telecommunications systems and assess whether the corrective mechanism lies in the market system or in a combination of public and private initiatives.

15. Another factor that may hinder the diffusion and application of information technology in some developing countries is the proliferation of

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17/ For a review of information networks and systems on the environment, see "Mechanisms for the transfer of environmentally sound technologies and international cooperation", a paper presented by P. Roffe at the Workshop on **"The Promotion of Access to and Dissemination of Information on Environmentally Sound Technologies"**, Seoul, Republic of Korea, 30 November to 2 December 1994. This paper also suggests that issues concerning the environment need to be brought to the forefront of the global information infrastructure agenda.

18/ See, Yehia, Soubra, op.cit, p.5.

19/ For a discussion on the concentration of telecommunications sector, see ibid, p.12.

standards. The existence of different information technology systems has meant that users become reluctant to invest in new systems that are incompatible with others currently installed in-house, as well as those used by partner firms - for example, subcontractors, equipment manufacturers and raw-material producers. The problems arising from the multiplicity of standards are compounded by the rapid rate of obsolescence due to technical change and the investments involved in support services.20/ The options for standardization, particularly at the national level, require further investigation.

16. The high cost of energy, the low capacity of the power-generation infrastructure, and the poor maintenance of power supply systems have also been major impediments to the application and diffusion of information technology systems in a number of developing countries. In many low-income developing countries, for example, there are frequent power supply interruptions and power surges large enough to cause serious damage to information technology systems and result in the loss of information.

17. As far as can be deduced from the available data, there appears to be a positive correlation between the rapid diffusion and application of information technology and the level of education, both general and technical. The experiences of the newly industrializing countries of Asia are illustrative. Some countries, for example Singapore, have demonstrated that, with a high level of general and technical education, "leapfrogging is possible and that countries could become advanced users of information technology without substantial information technology industrial capabilities."21/ A high literacy rate among the general population is essential, as well as the formulation of training programmes to improve computer literacy. In addition, people with special technical skills in computer sciences - for example, programming, data analysis, microcomputer processing and maintenance of information technology equipment - will also be required.

18. For developing countries wishing to accelerate the diffusion and application of information technology, investments in education in general and technical skills in particular are essential requirements. In some developing countries, particularly the least developed among them, literacy rates are as low as 27 per cent, as compared to over 90 per cent in the industrialized countries, the newly industrializing countries of Asia and certain economies in transition.22/ There is a need, therefore, for developing countries to invest in the upgrading of worker and management

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20/ See Yehia, Soubra, "Information technology and international competitiveness in construction services: opportunities and challenges", in **Information Technology and International Competitiveness: The Case of the Construction Services Industry**, United Nations: New York, 1993 (UNCTAD/ITD/TEC/6). Soubra explains that the reluctance of users to invest because of the incompatibility problem has " ..encouraged the formation of corporate ventures among IT companies that have hitherto been competitors; the motivations behind this move are to ensure increased systems compatibility and develop standards and innovative products and services at lower costs". See p, 27.

21/ Hanna, N. "Information technology policies in industrialized countries: A shift towards diffusion", in Information Technology for Development, ATAS Bulletin, issue 10 (forthcoming, 1995).

22/Human Development Report 1994, UNDP, New York.

skills through higher levels of formal education and specialized technical training. These skills can be provided partly by the formal education system and partly through in-firm training and autonomous training facilities provided jointly by business and government.

19. In brief, the revolution in information technology continues to transform the global economy through its effects on information processing, productivity and competitiveness. This revolution affects all aspects of society. As recently noted, the revolution ".. has only just begun, but already it's starting to overwhelm us. It's outstripping our capacity to cope, antiquating our laws, transforming our mores, reshuffling our economy, reordering our priorities, redefining our workplaces, invading our privacy, and shifting our concept of reality."23/ There is a consensus that the transition to the twenty-first century will witness a quantum leap in the development and exploitation of information technologies, with corresponding ramifications for social and economic organization, the environment, culture and the development of a global information infrastructure. The key issues of concern to policy-makers and international organizations are the extent to which this major transformation has benefited all aspects of society and the ways and means of achieving a truly global information infrastructure. Thus, it is timely for the United Nations Commission on Science and Technology for Development to give greater attention in its future work programme to the opportunities offered and challenges posed by the rapidly evolving information society.

Issues for further consideration

20. In setting the framework for the diffusion and application of information technology, countries need to take into account the rapid changes that are taking place in this field at the international level. Issues arising from different modes of technology transfer, property rights, standards of information technology systems, and globalization have a bearing on national actions. Moreover, efforts at the national level to enhance the diffusion of information technology need to consider the sectors in the national economy in which information technology is likely to play a significant role. More specifically, the following issues may require further exploration:

(i) The social impacts of the diffusion of information technology. In the area of employment, one needs to assess the impact of information technology in both the short and the long term. This issue is particularly pertinent for developing countries, where unskilled labour is in abundant supply. It is essential to investigate the skill requirements for information technology diffusion and also the effects of this diffusion on the skill and gender composition as well as on the organization of the workforce in the workplace. How can training and retraining activities be organized to stimulate information technology diffusion and reduce the possible immediate adverse effects of information technology on employment?

(ii) The institutional and infrastructural requirements for the diffusion of information technology in developing countries. Actual information needs, existing infrastructure, including telecommunications and power supply, local information resources and technological capabilities should be assessed and conditions for their improvement discussed. In this respect, it is important to ask what the effect will be of the development of a global Information Infrastructure on countries which - because of various infrastructural deficiencies such as poor telecommunications systems and the high costs of the service - will not be able to make use of it. Also, what are the key institutional and administrative structures necessary for the diffusion of information technology?

23/ See, "Technology 1995: The hype and the Hope", Newsweek, special issue on information technology, 27 February 1995.

(iii) The proliferation of networks and the legal implications involved, particularly regarding privacy, security of information and proprietary issues, need to be examined. As the potential increases for information technology to secure and manipulate detailed information, the demand for the protection of individual privacy and a company's confidential data is likely to increase. How, therefore, can the privacy of the individual with regard to personal data processing be protected? The revolution in information technology poses great challenges to the traditional forms of protection. The relevance of existing proprietary norms to the new technologies, particularly information technology, needs to be explored. Do the recent revolutionary changes in information technology require changes and new approaches to the traditional forms of legal protection? In this respect, is it relevant also to explore the effects of the new intellectual property structure emerging as part of the Uruguay Round on the development, transfer, diffusion and application of information technology in developing countries? Another important issue which requires further exploration concerns the implications of the multiplicity of standards for the expansion of low-end networking and the diffusion and application of information technology in developing countries;

(iv) The appropriate approaches to the diffusion and application of information technology, particularly in developing countries, need to be further explored. The diffusion of information technology can be achieved through market mechanisms and/or policy intervention. The latter can be divided into two categories: general policy and a selective approach. Although these two approaches to policy intervention can be complementary, they reflect different development objectives and different perceptions of the effects of policies and markets. The implications of the various approaches to the diffusion of information technology on competitiveness and the accumulation of technological capabilities need to be analysed. Furthermore, the options of selective strategies and a general policy for diffusion of information technology require further investigation. Which of these approaches is better suited to developing countries? Under what conditions could combinations of these approaches be useful? What are the merits and demerits of pursuing these approaches for low-income developing countries?

(v) Given the different levels of technological advancement of developing countries, there is a need to identify the areas/sectors where information technology can be effectively utilized to enhance the comparative advantage of the countries concerned. In the case of some economies in transition, the key issue is how to convert existing information technology capability in military-related industries - in terms of both technical personnel and physical infrastructure -- into civilian uses. In most developing countries, attention should be given to the actual and potential benefits of information technology diffusion in public administration and public services. In this connection, an issue of relevance to the science and technology community relates to the potential role of information technology in the transfer and diffusion to the developing world of technologies in the public domain. The options for facilitating such transfers through international cooperation need to be explored.